Kiwa Dare

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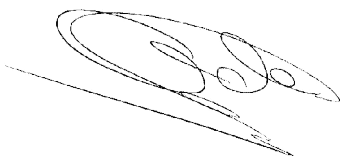
Test report

Electromagnetic compatibility

Product:	Solar NRG 3000
Model:	40.10.0000.08
Report number:	20220066RPT01
Status report:	Final
Date of report:	2022 March, 8
Applicant:	Dual Inventive Belgiëstraat 5 5061 KG Oisterwijk The Netherlands
Applicant's representative:	Mr. J.A.M. Maas
In the capacity of:	Manufacturer

Test engineer(s):	Author:	Approved by:
		
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1 Conclusion

The Solar NRG 3000 meets the class A emission limits as described in EN 50121-4 (2016) & RLN00007 V007 (2020).

The Solar NRG 3000 meets the levels as described in EN 50121-4 (2016) & RLN00007 V007 (2020). This is based on the tested mode of operation(s), the applicable performance criteria and the acceptance criteria as specified by the customer.

Remarks

It is the responsibility of the manufacturer to ensure, that all of the following products are equal to the measured sample. And as such ensure that all manufactured Solar NRG 3000s are in compliance with the harmonised standards under EMC directive 2014/30/EU, as mentioned above.

Furthermore, in order to fulfil the European CE-legislation, it is the responsibility of the manufacturer of the equipment to draw up a declaration of conformity and to have technical file documentation containing information to demonstrate the conformity of the product to the applicable requirements. At the same time, every unit brought to the market or put into service has to be marked with the CE-mark.

1.1 Summary of results

Compliance table

A summary of the test results gained from testing the Solar NRG 3000 is shown in the table below.

Category	Standard	Class / level	Result (Pass / Fail)
Emission	EN 50121-4 (2016) & RLN00007 V007 (2020)	EN-IEC 61000-6-2	Pass
Immunity	EN 50121-4 (2016) & RLN00007 V007 (2020)	RLN00007 V007 (2020), table Appendix 2	Pass

Note 1: The test results presented in this report relate only to the tested sample(s).
Note 2: The test results are based on the tested mode of operation(s), the applicable performance criteria and the acceptance criteria as specified by the customer.

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Overview of performed tests and measurements

The following table gives a summary of the results of the tests that have been carried out on the Solar NRG 3000.

Test sequence	Test description	Basic standard	EUT modified during test (yes/no)	Result (Pass/Fail)
1	Conducted emission, test with an AMN	EN 55016-2-1 (2014)/AC (2020) + A1 (2017)	No	Pass
--	Conducted emission at telecommunication ports, test with an AAN	EN 55022 (2010) + AC (2011)	--	Not applicable
--	Conducted emission at telecommunication ports, test with a current probe	EN 55022 (2010) + AC (2011)	--	Not applicable
--	Conducted emission at telecommunication ports, test with a capacitive voltage probe[1] & current probe	EN 55022 (2010) + AC (2011)	--	Not applicable
6	Radiated emission up to 1 GHz (SAC)	EN 55016-2-3 (2017)	No	Pass
--	Radiated emission above 1 GHz (FAC)	EN 55016-2-3 (2017)	--	Not applicable
--	Harmonics	EN-IEC 61000-3-2 (2014) & EN-IEC 61000-3-2 (2019) (not yet harmonized)	--	Not applicable
--	Flicker	EN-IEC 61000-3-3 (2013)	--	Not applicable
5	ESD	EN-IEC 61000-4-2 (2009)	No	Pass
7	Radiated immunity	EN-IEC 61000-4-3 (2006) + A1 (2008) + A2 (2010)	No	Pass
3	EFT	EN-IEC 61000-4-4 (2012)	No	Pass
--	Surge	EN-IEC 61000-4-5 (2014) + A1 (2017)	--	Not applicable
2	Conducted immunity	EN-IEC 61000-4-6 (2014)	No	Pass
4	Power frequency magnetic field	EN-IEC 61000-4-8 (2010)	No	Pass

[1] Tests are excluded from accreditation.

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The table below shows details about tests that are not applicable.

Phenomenon	Comment
Conducted emission, signal/ control ports (AAN/CVP/CP)	The EUT does not have signal or control ports.
Conducted emission, telecommunication/network ports (AAN/CVP/CP)	The EUT does not have multi-user telecommunications / network ports such as ISDN or Ethernet.
Radiated emission above 1 GHz (FAC)	According the applicant the highest frequency of the internal sources of the EUT is below 108 MHz.
Harmonics (I ≤ 16 A per phase)	The EUT is not AC supplied.
Flicker (I ≤ 16 A per phase)	The EUT is not AC supplied.
Harmonics (16 A < I ≤ 75 A per phase)	The EUT is not AC supplied.
Flicker (I ≤ 75 A per phase)	The EUT is not AC supplied.
Surge	The EUT is not AC supplied. The EUT does not have I/O cables longer than 30 m.
Pulsed magnetic field	The EUT is not vital equipment such as interlocking or command and control which are mounted in areas where a high risk of interference from mobile radio telephones has been identified.
Voltage dips and voltage variations	The EUT is not AC supplied.
Traction frequency	The EUT is not used in the 25kV/50Hz environment
50Hz common mode (CM) disturbance	The EUT does not have I/O cables longer than 20 m, in accordance with the basic standard EN 61000-4-16.

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2 General information

Introduction

Kiwa Dare is requested by Dual Inventive, to perform electromagnetic compatibility (EMC) tests.

The objective of the test was to assess the Solar NRG 3000 in accordance with the standards as mentioned in chapter 5 of this report, within the framework of the CE marking process. This report may only be used for this purpose.

At request of Dual Inventive, the EMC tests are carried out in order to find out whether the product complies with the harmonised European standards under the EMC Directive 2014/30/EU.

The test sample(s) were received on 2022 March, 03. Testing was performed on 2022 March, 03-04.

The tests are carried out at our facilities located in Woerden, The Netherlands.

The test results presented in this report relate only to the product tested.

In this report, the sample tested will be referred to as equipment under test (EUT).

This report is in conformity with ISO 17025.

Opinions or interpretations mentioned in this report are excluded from accreditation.

All tests as described in the applied standard(s) are carried out, unless otherwise specified in this report.

Report revision history

Report number	Revision	Date	Remarks
20220066RPT0	1	2022 March, 08	Initial report

Explanation status report

Status	Explanation
Draft	Preliminary unsigned report
Final	Formally signed report, with a final conclusion. Changes in the report will lead to a new report with a new report number.

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Measurement uncertainties

The reported expanded uncertainty of measurement is based on a standard uncertainty of measurement multiplied by a coverage factor of k = 2, providing a level of confidence of approximately 95 %, but excluding the contribution of the EUT. For emission tests, the expanded uncertainty of measurement has been determined in accordance with EN 55016-4-2 (2011). For immunity tests, the expanded uncertainty of measurement has been determined in accordance with either the basic standard, or UKAS publication LAB34.

Possible test case verdicts

Verdict	Clarification
NA or not applicable:	Test does not apply to the EUT
P(ass):	EUT does meet the requirement
F(ail):	EUT does not meet the requirement
U(ndetermined):	Pass or fail could not be established
NR or not requested:	Test is not requested by customer
Compliant:	EUT is compliant with the requirement
Non-compliant:	EUT is not compliant with the requirement

During pass or fail decisions, the measurement uncertainty is not taken into account.

Test equipment

The instruments used to perform the tests are displayed in the appendix.

3 Standards and test plan

The EUT is assessed against the following requirements:

Standards

Category	Standard
Emission	EN 50121-4 (2016) & RLN00007 V007 (2020)
Immunity	EN 50121-4 (2016) & RLN00007 V007 (2020)

Test plan

Test plan	Deviations
Not available	Not applicable

If available, a test plan is used as a supplement.

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4 EUT details

Purpose, functional and physical description

The NRG 3000 (Green Hub 3000) is a power bank with an integrated solar panel in a single waterproof housing. It can supply the ZKL 3000 RC and ZKL 3000 RC-C with continuous power. As a result, rail workers no longer need to enter the track to replace batteries, which benefits their safety and the environment.

General EUT data

EUT details, provided by the client:

Item	Description
Name	Solar NRG 3000
Manufacturer	Dual Inventive
Brand	Dual Inventive
Model number	40.10.0000.08
Serial number	9000.0053
Rating voltage	Input voltage: 11-19V
Rating power	Approximately 10VA
Rating amperage	1.5A output
Power supply during test	See "Test considerations"
Dimensions (LxWxH)	40x56x17cm including solar panel
Software release	Not available
Hardware release	Not available
Environment to be used	Railway

Other EUT related data

The condition of the EUT during reception was undamaged and fully functional.
The highest generated or used frequency of the EUT is Below 108 MHz.

Test configuration

The EUT is tested as tabletop equipment.
EMC for radiated emission upper frequency to be measured is 1GHz.
According to the information of the customer, the class of emission is A.

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Interfaces to external objects

The cable connections to EUT and peripheral equipment during testing are:

Description	Port type	Cable length	Max cable length	Type of cable	Fixing shield	Load at port	Note
Output cable	DC supply	1.5m	<10m	Unshielded	Not applicable	Battery case	Several break-out wiring is applied in the various test set-ups
Input cable	DC supply	40cm	40cm	Unshielded	Not applicable	18 cell solar panel	An auxiliary DC supply is used during several test phenomenon

The maximum cable length is specified by the customer. It is the responsibility of the customer to clearly indicate in the user- or installation manual or on the product that the cable length must never be exceeded.

5 Operating conditions during test

Mode(s) of operation

The test mode(s) during testing were defined as:

Mode of operation	Description
Mode 1	Emission and immunity test mode

Acceptance criteria

The criteria for recording a malfunction of operating during the immunity tests are:

Mode of operation	Acceptance criterion
Mode 1	Emission and immunity test mode. Performance criterion A: The battery charges. Performance criterion B: The battery temporarily does not charge and returns to normal charging mode after the disturbance. Performance criterion C: Manual intervention is allowed to return the battery to normal charging mode.

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EUT monitoring

During immunity testing, the behaviour and performance of the EUT will be monitored by means of Using digital multimeters monitoring the voltage and current checks the performance of the EUT.
No representative was present to witness the testing on behalf of the applicant.
The appendix of this report shows photos of the test configuration during the tests.

Minimum dwell time

The minimum dwell time is determined prior to immunity testing. Besides the requirement of the applied standard(s), the applicant states that the minimum dwell time must be: 1 second.

Test considerations

Using an analogue regulated power supply with current limit at approximately 300mA and a voltage of 19V the performance of the solar panel of the EUT is simulated.

According the flowchart in RLN00007, Appendix 1 the EN-IEC 61000-6-2 and EN-IEC 61000-6-4 are to be followed. The EUT may exist within the 3m zone, however it is not used in a vital signaling or energy system, neither it is within an LPZ2 zone.

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6 Emission measurement results

6.1 Conducted emission, test with an AMN

Test method

The conducted emission tests at the supply port are carried out by means of an "artificial mains network" (AMN). The tests are recorded with a spectrum analyzer / EMI receiver. The tests are carried out in accordance with the applied standard(s) (see chapter 5) and the basic standard EN55016-2-1, where the first standard takes precedence.

Measurement uncertainty

The measurement uncertainty during testing is displayed in the table below.

Frequency	U (log)
9 kHz – 150 kHz (measurement at EUT port AMN)	± 4.1 dB
150 kHz – 30 MHz (measurement at EUT port AMN)	± 3.8 dB

Requirements

The requirements are laid down in the table below.

Frequency band	QP limit [dBµV]	AV limit [dBµV]
150 kHz - 500 kHz	79	66
500 kHz - 30 MHz	73	60

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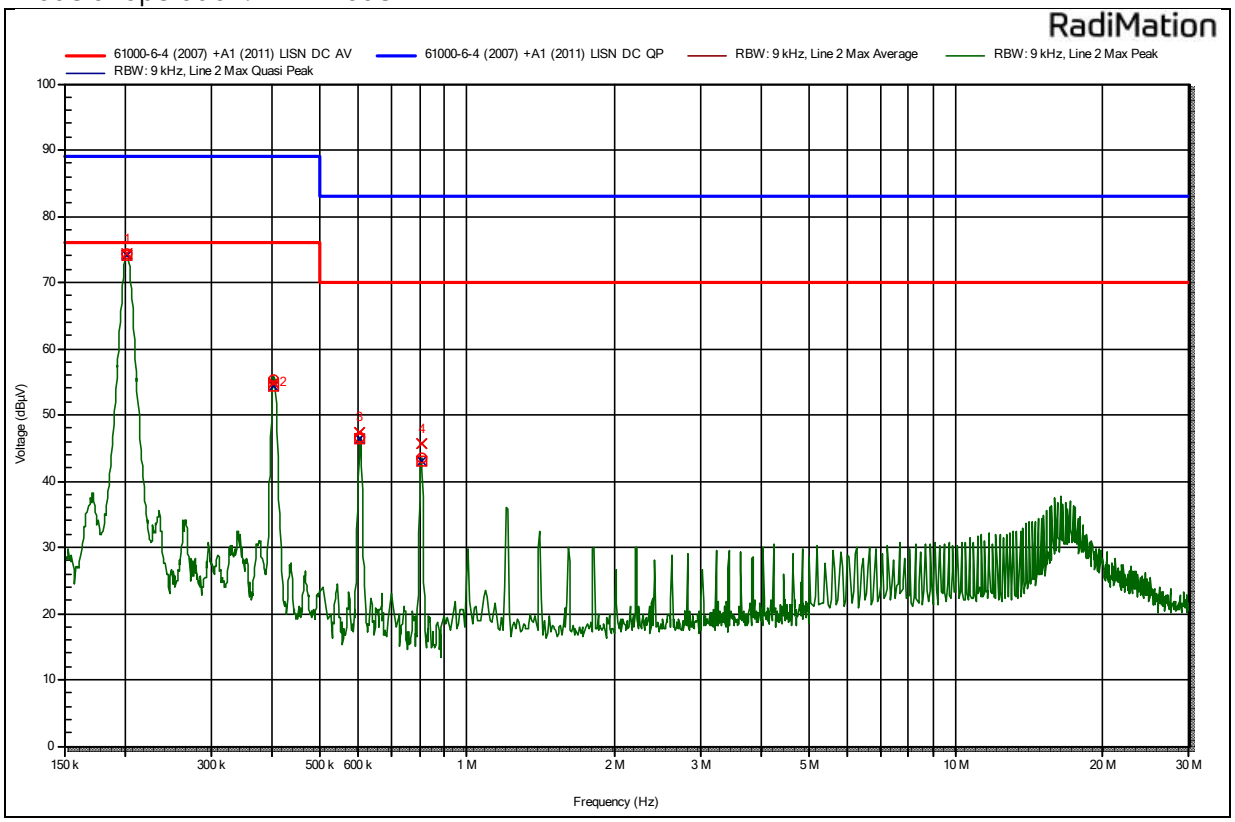
Measurement results

Conducted emission AMN 150 kHz to 30 MHz

Project number:	20220066	Test ID:	2
Bandwidth:	9 kHz	Line:	Line 2
Mode of operation:	Mode 1		



Detected peaks

Peak Number	Frequency (MHz)	Quasi-Peak (dBµV)	Quasi-Peak Limit (dBµV)	Average (dBµV)	Average Limit (dBµV)	Status
1	0.201	74.1	89	74.3	76	Pass
2	0.403	54.4	89	54.7	76	Pass
3	0.604	46.5	83	47.4	70	Pass
4	0.806	43.1	83	45.6	70	Pass

Remarks

The measured values are below the limits. Pass.

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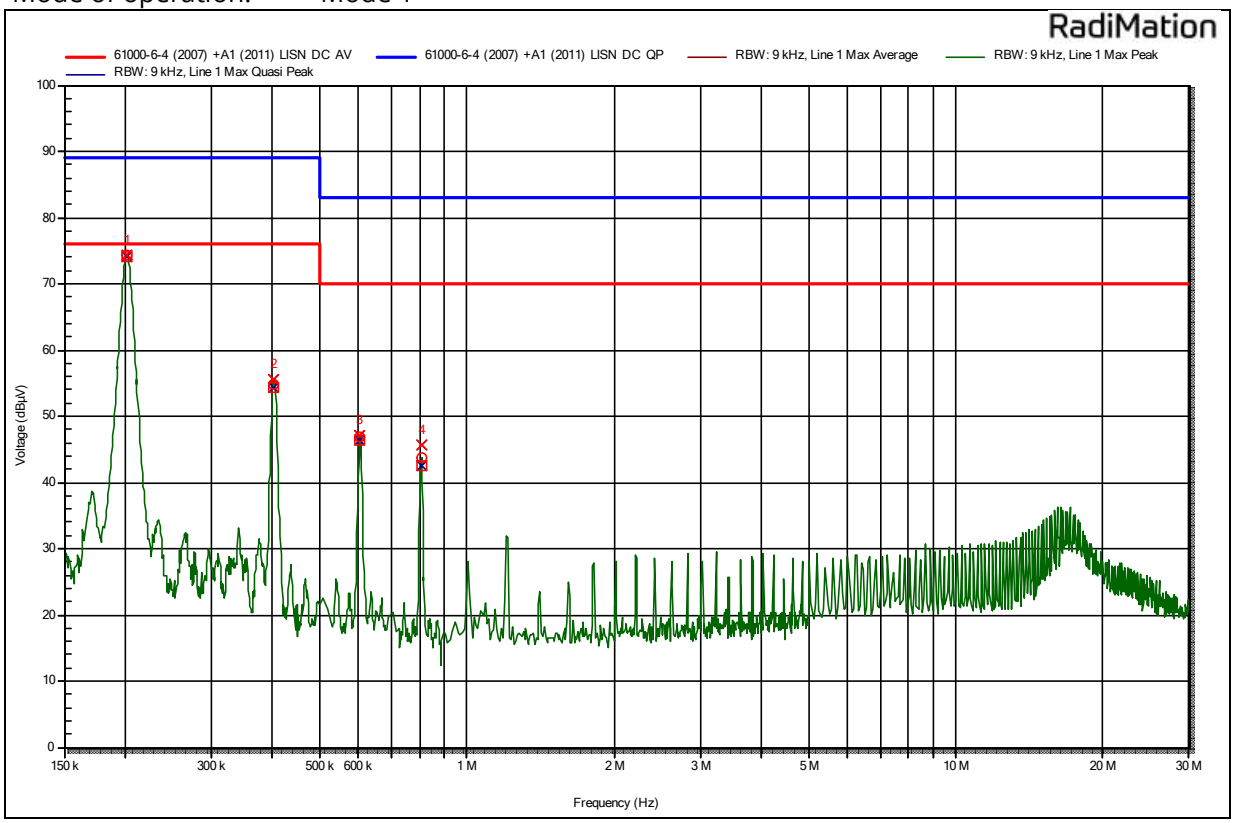
Conducted emission AMN 150 kHz to 30 MHz

Project number:	20220066	Test ID:	3
Bandwidth:	9 kHz	Line:	Line 1
Mode of operation:	Mode 1		



Detected peaks

Peak Number	Frequency (MHz)	Quasi-Peak (dBµV)	Quasi-Peak Limit (dBµV)	Average (dBµV)	Average Limit (dBµV)	Status
1	0.201	74.1	89	74.3	76	Pass
2	0.403	54.4	89	55.5	76	Pass
3	0.604	46.3	83	47.1	70	Pass
4	0.806	42.5	83	45.6	70	Pass

Remarks

The measured values are below the limits. Pass.

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6.1 Radiated emission up to 1 GHz (SAC)

Test method

The radiated emission tests are carried out in a semi anechoic chamber (SAC). The tests are recorded with a spectrum analyzer / EMI receiver.
The tests are carried out in accordance with the applied standard(s) (see chapter 5) and the basic standard EN55016-2-3, where the first standard takes precedence.
If applicable, common mode absorption devices (CMADs) are used on cabling leaving the test volume.

Measurement uncertainty

The measurement uncertainty during testing is displayed in the table below.

Frequency	U (log)
150 kHz – 30 MHz (current)	± 3.5 dB
150 kHz – 30 MHz (voltage)	± 4 dB

Requirements

The requirements are laid down in the table below.

Frequency band	QP limit @ 5 meter [dBµV/m]	QP limit @ 3 meter [dBµV/m]
30 MHz - 230 MHz	46	50
230 MHz - 1 GHz	53	57

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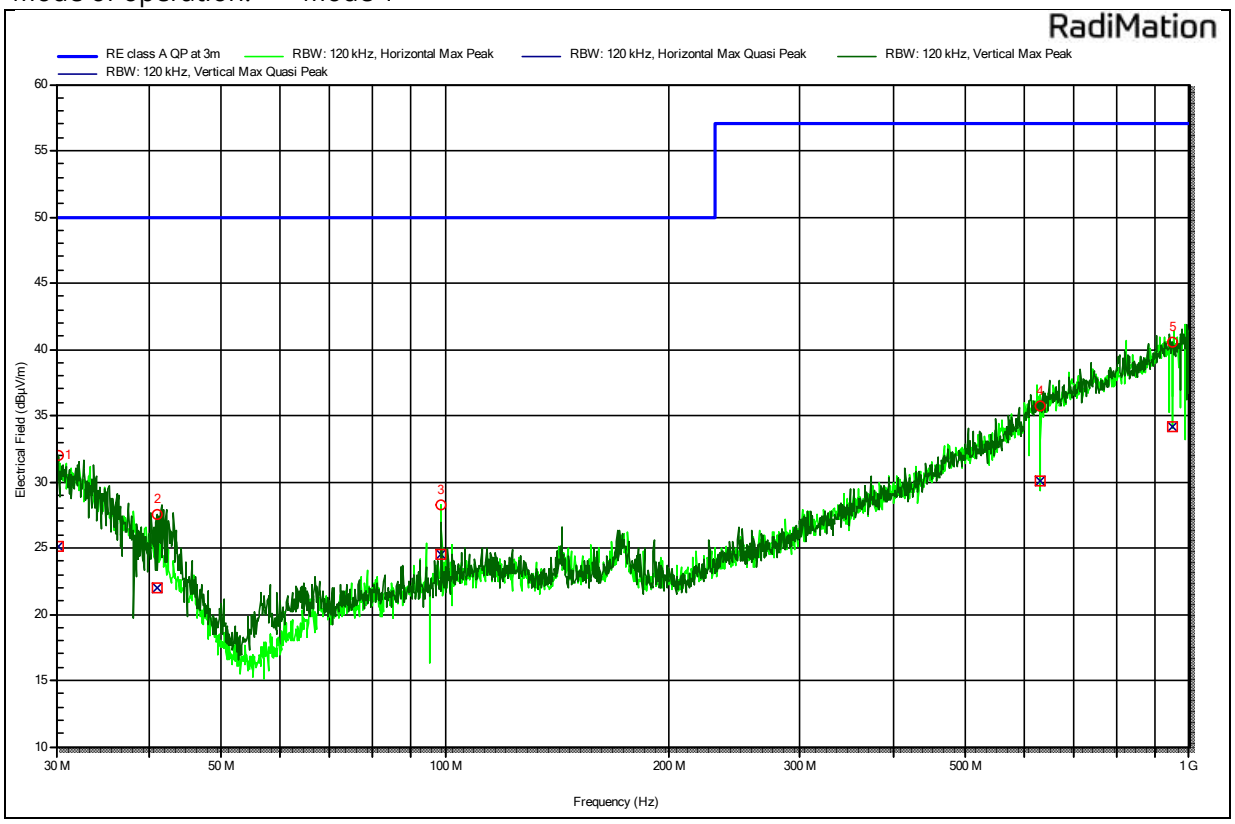
Measurement results

Radiated emission semi anechoic chamber 30.000 MHz to 1.000 GHz

Project number:	20220066	Test ID:	7
Antenna polarization:	Both	Antenna distance:	3 m
Bandwidth:	120 kHz	Antenna height:	1 - 4 m
Mode of operation:	Mode 1		



Detected peaks

Peak Number	Frequency (MHz)	Quasi-Peak (dBµV/m)	Quasi-Peak Limit (dBµV/m)	Angle (degrees)	Height (m)	Polarization	Status
1	30.153	25.1	50	128	2.5	Vertical	Pass
2	40.971	22	50	125	1	Vertical	Pass
3	98.873	24.5	50	318	2.8	Horizontal	Pass
4	631.094	30.1	57	23	3.5	Horizontal	Pass
5	950.782	34.2	57	-137	1.7	Horizontal	Pass

Remarks

The measured values are below the limits. Pass.

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7 Immunity test results

7.1 Electrostatic discharges (ESD)

Test method

The immunity tests to ESD are carried out in accordance with the applied standard(s) (see chapter 5) and the basic standard EN61000-4-2, where the first standard takes precedence. Beside the test levels as described in the standard EN 50121-4 (2016) & RLN00007 V007 (2020), all voltages of the lower test levels as described in the basic standard are tested.

Measurement uncertainty

It has been demonstrated that the test generator meets the specified requirements in the standard with at least 95 % confidence.

Requirements

The requirements are laid down in the table below.

Type of discharge	Test level	Performance criterion
Air discharge	0 - ±8 kV	B
Contact discharge	0 - ±6 kV	B

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Test results

Electrostatic discharge test

Project number	20220066
Test ID	6
Temperature	20 °Celsius
Humidity	45 %
Mode of operation	Mode 1
Remarks	Pass, no influence observed. The lower test levels are tested also. Air discharge at the solar panel is simulated through air discharge at the solar input wiring.

Settings

Parameter	Value
Number of single discharges at each spot	10
Time interval between discharges	1 sec.

Test results air discharge

Discharge location	Testlevel	Note	Result
Enclosure (See discharge points in ESD pictures)	8 kV	See remarks	Pass
Enclosure (See discharge points in ESD pictures)	-8 kV	See remarks	Pass

Test results contact discharge

Discharge location	Testlevel	Note	Result
Enclosure (See discharge points in ESD pictures)	4 kV	See remarks	Pass
Enclosure (See discharge points in ESD pictures)	-4 kV	See remarks	Pass

Test results at horizontal coupling plane

Discharge location	Testlevel	Note	Result
Enclosure (See discharge points in ESD pictures)	4 kV	See remarks	Pass
Enclosure (See discharge points in ESD pictures)	-4 kV	See remarks	Pass

Test results at vertical coupling plane

Discharge location	Testlevel	Note	Result
Enclosure (See discharge points in ESD pictures)	4 kV	See remarks	Pass
Enclosure (See discharge points in ESD pictures)	-4 kV	See remarks	Pass

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7.2 Radiated immunity

Test method

The radiated immunity tests are carried out in a full anechoic room, in accordance with the applied standard(s) (see chapter 5) and the basic standard EN61000-4-3, where the first standard takes precedence.

Measurement uncertainty

The measurement uncertainty during testing is displayed in the table below.

Frequency	U (log)
26 MHz – 6 GHz	± 2.1 dB

Requirements

The requirements are laid down in the table below.

Antenna polarization	Test level	Frequency range	Performance criterion
Horizontal	10 V/m	80 – 1000 MHz	A
Vertical	10 V/m	80 – 1000 MHz	A
Horizontal	20 V/m	380 – 470 MHz	A
Vertical	20 V/m	380 – 470 MHz	A
Horizontal	20 V/m	800 – 1000 MHz	A
Vertical	20 V/m	800 – 1000 MHz	A
Horizontal	10 V/m	1000 – 2000 MHz	A
Vertical	10 V/m	1000 – 2000 MHz	A
Horizontal	5 V/m	2000 – 2700 MHz	A
Vertical	5 V/m	2000 – 2700 MHz	A
Horizontal	3 V/m	2700 – 6000 MHz	A
Vertical	3 V/m	2700 – 6000 MHz	A

Test results

Radiated immunity test 80 MHz to 1 GHz Horizontal

Project number	20220066
Test ID	8
Mode of operation	Mode 1, front side of EUT
Angle, observation and result	Pass, no influence observed.

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Settings

Frequency step	Modulation	Dwell time	Test level	Distance
logarithmic step of 1%	1000 Hz. 80% AM	1 s	Variable test-level	3 m

Radiated immunity test 80 MHz to 1 GHz Vertical

Project number	20220066
Test ID	9
Mode of operation	Mode 1, front side of EUT
Angle, observation and result	Pass, no influence observed.

Settings

Frequency step	Modulation	Dwell time	Test level	Distance
logarithmic step of 1%	1000 Hz. 80% AM	1 s	Variable test-level	3 m

Radiated immunity test 80 MHz to 1 GHz Vertical

Project number	20220066
Test ID	10
Mode of operation	Mode 1, right side of EUT
Angle, observation and result	Pass, no influence observed.

Settings

Frequency step	Modulation	Dwell time	Test level	Distance
logarithmic step of 1%	1000 Hz. 80% AM	1 s	Variable test-level	3 m

Radiated immunity test 80 MHz to 1 GHz Horizontal

Project number	20220066
Test ID	11
Mode of operation	Mode 1, right side of EUT
Angle, observation and result	Pass, no influence observed.

Settings

Frequency step	Modulation	Dwell time	Test level	Distance
logarithmic step of 1%	1000 Hz. 80% AM	1 s	Variable test-level	3 m

Radiated immunity test 80 MHz to 1 GHz Horizontal

Project number	20220066
Test ID	12
Mode of operation	Mode 1, left side of EUT
Angle, observation and result	Pass, no influence observed.

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Settings

Frequency step	Modulation	Dwell time	Test level	Distance
logarithmic step of 1%	1000 Hz. 80% AM	1 s	Variable test-level	3 m

Radiated immunity test 80 MHz to 1 GHz Vertical

Project number	20220066
Test ID	13
Mode of operation	Mode 1, left side of EUT
Angle, observation and result	Pass, no influence observed.

Settings

Frequency step	Modulation	Dwell time	Test level	Distance
logarithmic step of 1%	1000 Hz. 80% AM	1 s	Variable test-level	3 m

Radiated immunity test 80 MHz to 1 GHz Vertical

Project number	20220066
Test ID	14
Mode of operation	Mode 1, rear side of EUT
Angle, observation and result	Pass, no influence observed.

Settings

Frequency step	Modulation	Dwell time	Test level	Distance
logarithmic step of 1%	1000 Hz. 80% AM	1 s	Variable test-level	3 m

Radiated immunity test 80 MHz to 1 GHz Horizontal

Project number	20220066
Test ID	15
Mode of operation	Mode 1, rear side of EUT
Angle, observation and result	Pass, no influence observed.

Settings

Frequency step	Modulation	Dwell time	Test level	Distance
logarithmic step of 1%	1000 Hz. 80% AM	1 s	Variable test-level	3 m

Radiated immunity test 1 GHz to 6 GHz Horizontal

Project number	20220066
Test ID	16
Mode of operation	Mode 1, front side of EUT
Angle, observation and result	Pass, no influence observed.

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Settings

Frequency step	Modulation	Dwell time	Test level	Distance
logarithmic step of 1%	1000 Hz. 80% AM	2 s	Variable test-level	3 m

Radiated immunity test 1 GHz to 6 GHz Vertical

Project number	20220066
Test ID	17
Mode of operation	Mode 1, front side of EUT
Angle, observation and result	Pass, no influence observed.

Settings

Frequency step	Modulation	Dwell time	Test level	Distance
logarithmic step of 1%	1000 Hz. 80% AM	2 s	Variable test-level	3 m

Radiated immunity test 1 GHz to 6 GHz Vertical

Project number	20220066
Test ID	18
Mode of operation	Mode 1, left side of EUT
Angle, observation and result	Pass, no influence observed.

Settings

Frequency step	Modulation	Dwell time	Test level	Distance
logarithmic step of 1%	1000 Hz. 80% AM	2 s	Variable test-level	3 m

Radiated immunity test 1 GHz to 6 GHz Horizontal

Project number	20220066
Test ID	19
Mode of operation	Mode 1, left side of EUT
Angle, observation and result	Pass, no influence observed.

Settings

Frequency step	Modulation	Dwell time	Test level	Distance
logarithmic step of 1%	1000 Hz. 80% AM	2 s	Variable test-level	3 m

Radiated immunity test 1 GHz to 6 GHz Horizontal

Project number	20220066
Test ID	20
Mode of operation	Mode 1, right side of EUT
Angle, observation and result	Pass, no influence observed.

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Settings

Frequency step	Modulation	Dwell time	Test level	Distance
logarithmic step of 1%	1000 Hz. 80% AM	2 s	Variable test-level	3 m

Radiated immunity test 1 GHz to 6 GHz Vertical

Project number	20220066
Test ID	21
Mode of operation	Mode 1, right side of EUT
Angle, observation and result	Pass, no influence observed.

Settings

Frequency step	Modulation	Dwell time	Test level	Distance
logarithmic step of 1%	1000 Hz. 80% AM	2 s	Variable test-level	3 m

Radiated immunity test 1 GHz to 6 GHz Vertical

Project number	20220066
Test ID	22
Mode of operation	Mode 1, rear side of EUT
Angle, observation and result	Pass, no influence observed.

Settings

Frequency step	Modulation	Dwell time	Test level	Distance
logarithmic step of 1%	1000 Hz. 80% AM	2 s	Variable test-level	3 m

Radiated immunity test 1 GHz to 6 GHz Horizontal

Project number	20220066
Test ID	23
Mode of operation	Mode 1, rear side of EUT
Angle, observation and result	Pass, no influence observed.

Settings

Frequency step	Modulation	Dwell time	Test level	Distance
logarithmic step of 1%	1000 Hz. 80% AM	2 s	Variable test-level	3 m

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7.3 Electrical fast transients (EFT)

Test method

The EFT tests are carried out in accordance with the applied standard(s) (see chapter 5) and the basic standard EN61000-4-4, where the first standard takes precedence.

Measurement uncertainty

It has been demonstrated that the test generator meets the specified requirements in the standard with at least 95 % confidence.

Requirements

The general requirements are laid down in the table below.

Port type	Test level	Coupling of disturbances	Performance criterion
I/O	0 - ±2.0 kV	Clamp	A
DC	0 - ±2.0 kV	Coupling network	A
AC	0 - ±2.0 kV	Coupling network	A
Earth	0 - ±1.0 kV	Coupling network	A

For EUT's connected to circuits with B-relays, the requirements are laid down in the table below.

Port type	Test level	Coupling of disturbances	Performance criterion
I/O	0 - ±4.0 kV	Clamp	A
DC	0 - ±4.0 kV	Coupling network	A
AC	0 - ±4.0 kV	Coupling network	A
Earth	0 - ±4.0 kV	Coupling network	A

Test parameters

The parameters are laid down in the tables below.

Parameter	Value
Duration positive polarity	60 sec.
Duration negative polarity	60 sec.

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Test results

Electrical fast transient/burst immunity test at Output cable

Project number	20220066
Test ID	5
Temperature (°C)	20 °Celsius
Humidity [%]	45 %
Mode of operation	Mode 1
Remarks	Pass, no influence observed.

Test sequence	Type of test	Test level(V)	Influence during test	Result
5	Pos./Neg. to Ref.	2000	See remarks	Pass

7.4 Conducted immunity

Test method

The conducted immunity tests are carried out in accordance with the applied standard(s) (see chapter 5) and the basic standard EN61000-4-6, where the first standard takes precedence.

Measurement uncertainty

The measurement uncertainty during testing is displayed in the table below.

Frequency	U (log)
150 kHz – 230 MHz, induction voltage EM clamp	± 3.3 dB
150 kHz – 230 MHz, induction voltage CDN	± 1.7 dB
150 kHz – 230 MHz, measuring current	± 2.7 dB

Requirements

The requirements are laid down in the table below.

Port type	Test level	Performance criterion
All	10 Vrms	A

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Test results

Conducted immunity test 150 kHz to 80 MHz

Project number	20220066
Test ID	4
Mode of operation	Mode 1
Port type (name), observation and result	Pass, no influence observed.

Settings

Frequency step	Modulation	Dwell time	Test level
logarithmic step of 1%	1000 Hz. 80% AM	1 s	10 V

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7.5 Power frequency magnetic field

Test method

The power frequency magnetic field tests are carried out in accordance with the applied standard(s) (see chapter 5) and the basic standard EN61000-4-8, where the first standard takes precedence.

Measurement uncertainty

The measurement uncertainty during testing is displayed in the table below.

Frequency	U (log)
50 Hz, 60 Hz	± 0.4 dB

Requirements

The requirements are laid down in the table below.

Field direction	Frequency	Test level	Dwell time	Performance criterion
X, Y, Z	0 Hz 16,67 Hz 50 Hz	300 A/m 100 A/m (rms) 100 A/m (rms)	≥10 s ≥10 s ≥10 s	A A A

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Test results

Power frequency magnetic field immunity test

Project number	20220066
Remarks	

Settings

Test level [A/m]: see below	Dwell time [sec]: >20

Test specifications		Antenna polarization	Mode of operation	Observation	Performance criterion required	Performance criterion attained	Pass / Fail
f (Hz)	Test level (A/m)						
16,7 Hz	100 A/m rms	X	Mode 1	No influence observed	A	A	Pass
		Y	Mode 1	No influence observed	A	A	Pass
		Z	Mode 1	No influence observed	A	A	Pass
50 Hz	100 A/m rms	X	Mode 1	No influence observed	A	A	Pass
		Y	Mode 1	No influence observed	A	A	Pass
		Z	Mode 1	No influence observed	A	A	Pass
0 Hz (DC)	300 A/m	X	Mode 1	No influence observed	A	A	Pass
		Y	Mode 1	No influence observed	A	A	Pass
		Z	Mode 1	No influence observed	A	A	Pass

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8 Appendix A: General performance criteria

Performance criterion	Description
A	The apparatus shall continue to operate as intended during and after the test. No degradation of performance or loss of function is allowed below a performance level specified by the manufacturer, when the apparatus is used as intended. The performance level may be replaced by a permissible loss of performance. If the minimum performance level or the permissible performance loss is not specified by the manufacturer, either of these may be derived from the product description and documentation, and by what the user may reasonably expect from the apparatus if used as intended.
B	The apparatus shall continue to operate as intended after the test. No degradation of performance or loss of function is allowed below a performance level specified by the manufacturer, when the apparatus is used as intended. The performance level may be replaced by a permissible loss of performance. During the test, degradation of performance is however allowed. No change of actual operating state or stored data is allowed. If the minimum performance level or the permissible performance loss is not specified by the manufacturer, either of these may be derived from the product description and documentation and what the user may reasonably expect from the apparatus if used as intended.
C	Temporary loss of function is allowed, provided the function is self-recoverable or can be restored by the operation of the controls.

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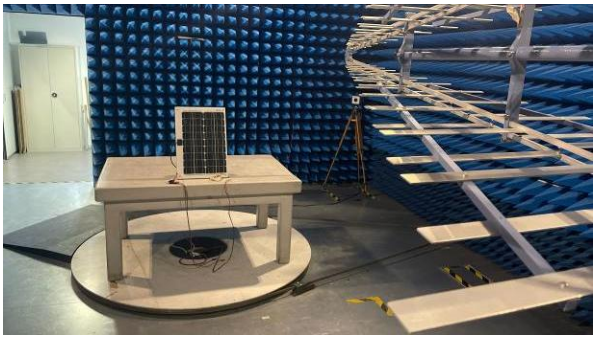
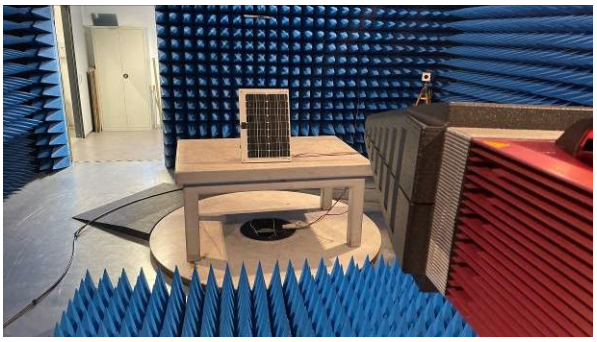
9 Appendix B: Photos

Conducted Emission setup



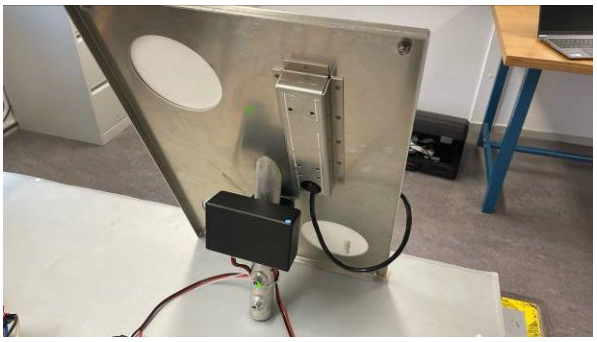
Radiated emission setup

Radiated immunity 200-1000MHz setup



Radiated immunity 1000-2000MHz setup

ESD discharge point



ESD discharge point

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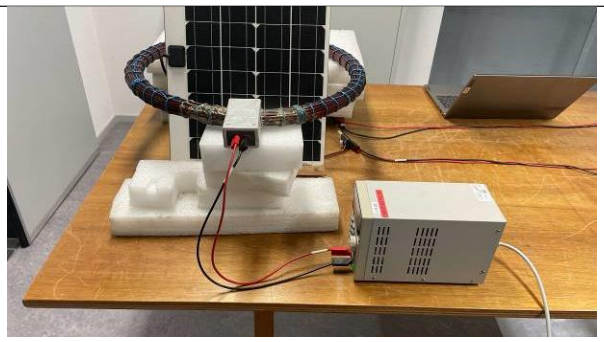
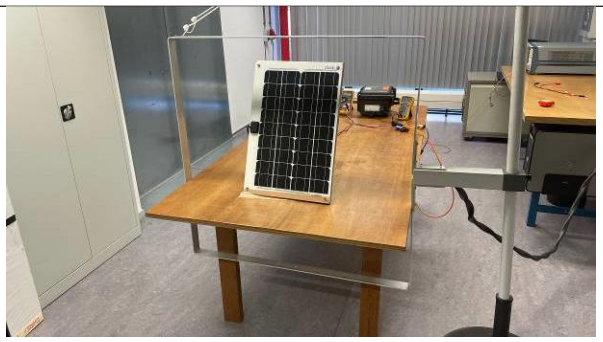
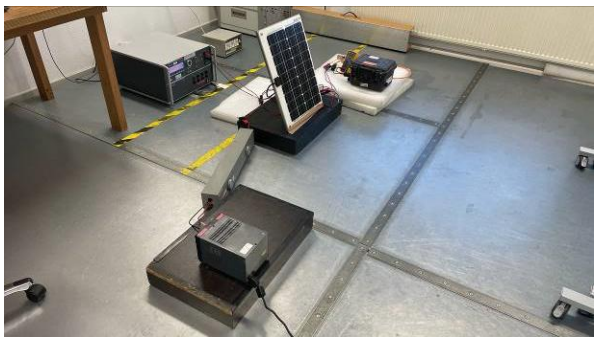


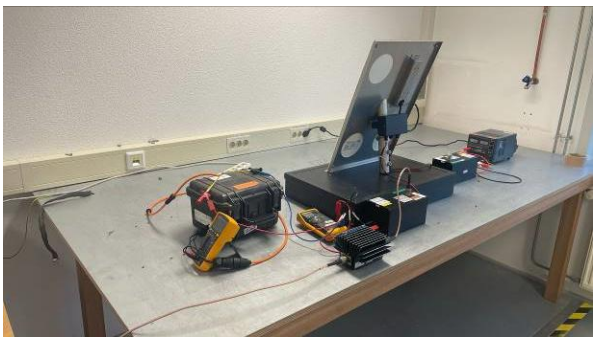
Magnetic field immunity 0 Hz (DC) setup



Magnetic field immunity 50Hz setup



EFT setup



Conducted immunity setup

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10 Appendix E: Equipment list

Conducted emission AMN 150 kHz to 30 MHz

Device Type	Brand	Type	ID
Cable preamp -> analyser	Huber & Suhner	RG142	1226
LISN	Schwarzbeck+Minicircuits	NSLK8126+BW-N10W5	1607+1744
Spectrum analyser	Rohde & Schwarz	ESIB 26	1691

Radiated emission semi anechoic chamber 30 MHz to 1000 MHz

Device Type	Brand	Type	ID
Cable antenna -> preamp	RFS	Cellflex SCF12-50J	1496
Antenna	Rohde & Schwarz	HL 562	1527
Spectrum analyser	Rohde & Schwarz	ESU 8 Input 2 (LAN)	1556
Antenna tower	DARE!! Instruments	RadiTower RAT1001B + RPL2010A	1569+1496
Turn table	DARE!! Instruments	RadiTurn (RadiCentre)	1569+1367
Cable preamp -> analyser	Pasternack / Huber & Suhner	RG217 / Sucofeed_1/2	1478

ESD

Device Type	Brand	Type	ID
Climate chamber	ESPEC	PMS-CA	2058
Switch matrix	Netatmo	NIM01-WW	1799
ESD gun	EMC-Partner	ESD 3000	1753

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Radiated immunity 80 MHz to 1000 MHz

Device Type	Brand	Type	ID
Amplifier	Prâna	MT 200 SC	1537
Signal generator	DARE!! Instruments	RGN6000B	1567
Antenna	Rohde & Schwarz	HL 562 with folded rear elements	1527
Turn table	DARE!! Instruments	RadiTurn	1367
AD convertor	D.A.R.E!! Development	RadiMate IV	1379
Coupler	Werlatone Inc.	C8719	1748
Forward power meter	DARE!! Instruments	RPR2018P	1648+1529
Reflected power meter	DARE!! Instruments	RPR1006A	1648+1498
Switch matrix	DARE!! Instruments	RSW1024S	1648
Cable SG -> amplifier	Huber & Suhner	RG142	1228
Cable coupler -> antenna	Huber & Suhner	Sucofeed_1/2	1225
Antenna tower	DARE!! Instruments	RadiTower RAT1001B + RPL2010A	1569+1496
Cable coupler -> antenna	RFS	Cellflex SCF12-50J	1496

Radiated immunity 1 GHz to 6 GHz

Device Type	Brand	Type	ID
Amplifier	DARE!! Instruments	RadiField RFS2006B	1651
Signal generator	DARE!! Instruments	RGN6000B	1567
Antenna	DARE!! Instruments	RadiField RFS2006B	1651
Turn table	DARE!! Instruments	RadiTurn	1367
AD convertor	D.A.R.E!! Development	RadiMate IV	1379
Coupler	DARE!! Instruments	RadiField RFS2006B	1651
Forward power meter	DARE!! Instruments	RadiField RFS2006B	1651
Reflected power meter	DARE!! Instruments	RadiField RFS2006B	1651
Switch matrix	DARE!! Instruments	RSW1024S	ID1648
Cable SG -> amplifier	Pasternack / Huber & Suhner	RG217 / Sucofeed_1/2	1478
Antenna tower	DARE!! Instruments	RadiField RFS2006B	1651

EFT

Device Type	Brand	Type	ID
Injection device	Haefely	IP4A	1796
EFT burst generator	EM test	UCS 500N	1557

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Conducted Immunity

Device Type	Brand	Type	ID
Amplifier	Amplifier Research	75A400	7387
Signal generator	Marconi	2024	1092
Sensor power meter	Hewlett Packard	437B	1018/1323/1216
Injection device	DARE!! Development	CDN-M2	1676+1159
Coupler	Amplifier Research	DC3001A	1536
Forward power meter	DARE!! Instruments	RPR1006A	1458
Reflected power meter	DARE!! Instruments	RPR1004A	1444
Jig	DARE!! Development	CDN-CAL-01	1271+1272
Cable SG -> amplifier	Huber & Suhner	RG142	1219
Cable coupler -> antenna	Huber & Suhner	RG142	1220

Magnetic fields

Description	Brand	Type no	I.D.
Power source	California Instruments.	5001iX	1324
Test generator	DARE!! Instruments	MF300A	1625
Inductive coil 300A	DARE!! Instruments	IS300A	1623
Current clamp meter	Chauvin Arnoux	F65	1642
Current clamp meter	Fluke	376	2101
EM field analyzer	Wandel & Goltermann	EFA-2 BN 2245	1152
B-Field sensor	Wandel & Goltermann	BN 2245/90.10	1153

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11 Appendix F: Abbreviations

List of used abbreviations in this report:

Abbreviation	Explanation
EMC	Electromagnetic compatibility
CE marking	Conformité Européenne marking
EUT	Equipment under test
SAC	Semi-anechoic chamber
FAC	Full-anechoic chamber
PK	Peak (detector)
QP	Quasi-peak (detector)
AV	Average (detector)
AM	Amplitude modulation
PM	Pulse modulation
CW	Continuous wave (unmodulated)
AMN	Artificial mains network
AAN	Asymmetric artificial network
CP	Current probe
CVP	Capacitive voltage probe
CDN	Coupling-decoupling network
ESD	Electrostatic discharges
EFT	Electrical fast transients
SA	Spectrum analyser
RC	Test receiver

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